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ABSTRACT

Several intermediate performance objectives and corresponding criterion measures are presented for each of six terminal objectives for a two-semester course (2 hours daily) which provides training in the terminology, construction, and function of both two- and four-cycle fuel-air mixture internal combustion engines with emphasis on outboard marine engines. This 360 hour basic course includes instruction and practical experience in the following: Safety, care and use of hand tools and manuals, theory of internal combustion, ignition and electrical systems, cooling systems, fuel systems, drive units, and engine control systems. The titles of the performance objectives are: Orientation, Tools, Engine Construction, Ignition System, Fuel System, and Drive Unit. (This manual and 54 others were developed for various secondary level vocational courses using the System Approach for Education (SAFE) guidelines). (HD)

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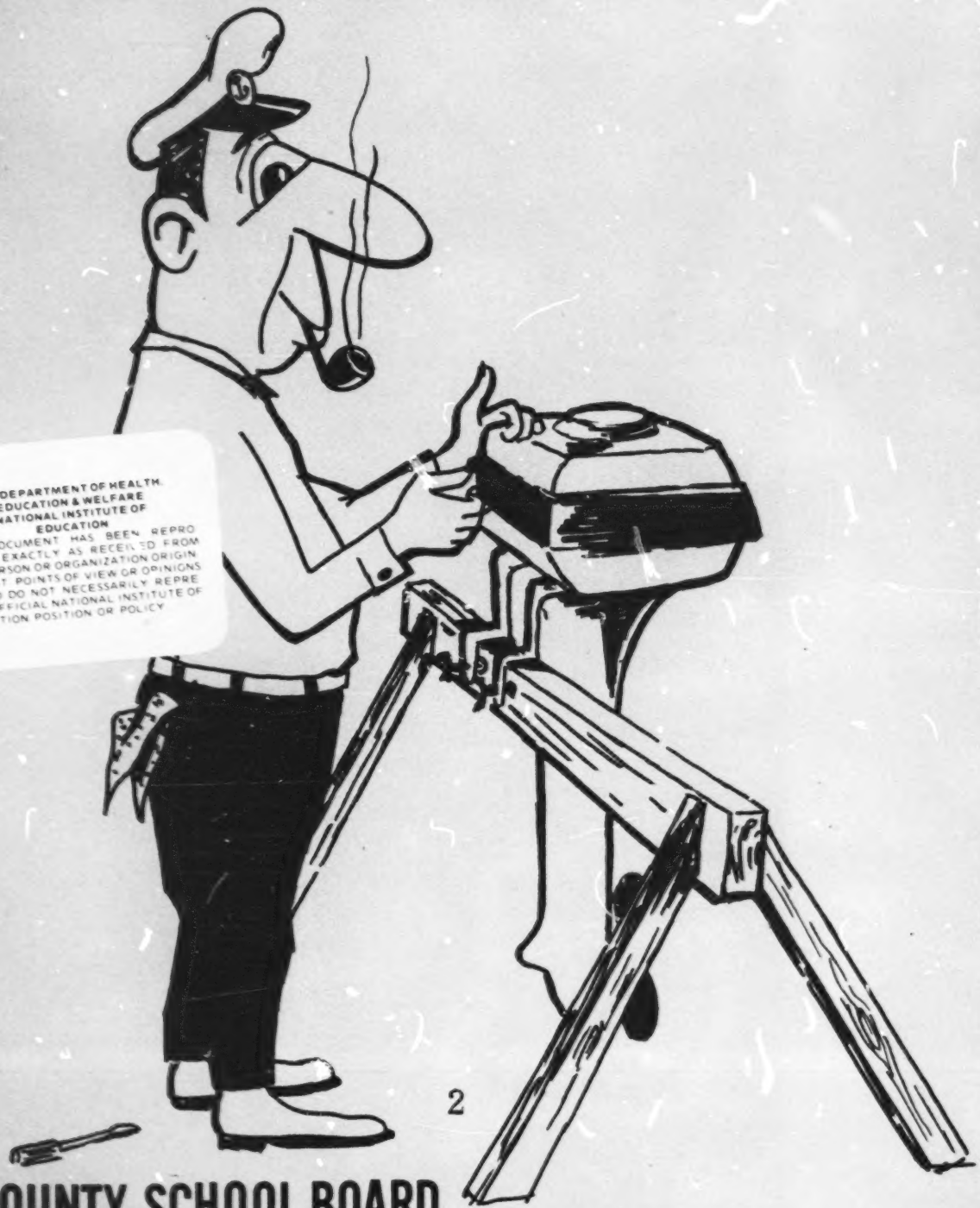
PERFORMANCE OBJECTIVES

MARINE ENGINE MECHANICS

BASIC COURSE



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July, 1972

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Industrial Education

Mr. Joseph Killough, Coordinator
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The following educator participated as the writer of this manual:

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MARINE ENGINE MECHANICS - BASIC

Accreditation No. 9363

Length of Course: 2 semesters

Time Block: 2 Hours Daily

COURSE DESCRIPTION

This 360 hour course provides training in the terminology, construction, and function of both two and four cycle fuel-air mixture internal combustion engines with emphasis on outboard marine engines. The course includes instruction and practical experience in the following:

A - Safety

B - Care and Use of Hand Tools and Manuals

C - Theory of Internal Combustion

D - Ignition and Electrical Systems

E - Cooling Systems

F - Fuel Systems

G - Drive Units

H - Engine Control Systems

9363 - MARINE ENGINE MECHANICS - BASIC

Syllabus of Terminal Performance Objectives

1.0 Orientation

2.0 Tools

3.0 Engine Construction

4.0 Ignition System

5.0 Fuel System

6.0 Drive Unit

CURRICULUM OBJECTIVE

Design, develop, implement and validate a three year curriculum in Marine Engine Mechanics for Duval County students. This curriculum will be implemented as a preliminary field test to begin in September 1972.

Upon completion of this program 85% of the students will achieve 75% proficiency on the following:

1. Teacher, made test (attached)
2. Practical demonstration of skills developed (attached)

Although attendance, mathematics, science and communications necessary to success in this field of employment are taught as related information, it is expected that a student entering this special course will already have an adequate general education upon which this course content may be presented. This will enable him to grasp and retain what is taught. A student who enters this course and who does not possess the essential foundation may not expect to succeed beyond mediocre attainment.

MARINE ENGINE MECHANICS

PRACTICAL DEMONSTRATION RATING SCALE

ITEMS TO BE RATED	PERCENT VALUE ASSIGNED
1. Planning	15%
a. Operation order	
b. Selection of tools and materials	
c. Use of trade knowledge	
2. Product	
a. Accuracy (free of mistakes)	40%
b. Precision (adherence to limits)	
c. Finish (as required)	
3. Work Habits	
a. Cleanliness	30%
b. Order	
c. Care of tools (inventory)	
d. Safety	
e. Economy of materials	
4. Moral-Attitude	15%
a. Cooperation	
b. Iniative	
c. Dependability	

ACCREDITATION NUMBER 9363

COURSE TITLE: MARINE ENGINE MECHANICS - BASIC

TERMINAL OBJECTIVE
OBJECTIVE NO. 1.0

ORIENTATION

The student will demonstrate his familiarity with career opportunities, student organizations, and shop safety practices by answering correctly 80% of the questions on a written test.

No.	Intermediate Performance Objectives	No.	Criterion Measures
1.1	Given a list of job titles, the student will select with 100% accuracy the titles related to this field.	1.1	Circle those areas related to this field: Marine Mechanics — Steam fitter Ind. Engine Mech. — Air Craft Mech. Parts man — Diesel Mech. Serv. Manager — Electrical Mech. Field Representative
1.2	Given a print out of general shop area student will locate position of all fire extinguisher on the print out.	1.2	Performance is evaluated by criterion stated in objective.
1.3	The student will identify orally or in writing at least 5 safety regulations.	1.3	Evaluated by criterion in objective.
1.4	The student will with 80% proficiency answer questions about student organizations available to him.	1.4	1. Name one club designed especially for Industrial Education students. 2. What does VICA mean? 3. Who can belong to VICA? 4. What benefits are derived from belonging to VICA?

FUNCTIONAL PERFORMANCE ANALYSIS

Terminal Performance Objective 1.0
Interim Performance Objective 1.1

No.	Learning Steps	No.	Criterion Performance Evaluation (Response)	No.	Method/Media Selection	Time Requir
1.1.1	In your own words describe why the trade has grown so rapidly in recent years.	1.1.1	State that due to shorter working hours and more leisure time, more people than ever before are developing hobbies of fishing, boating, water-skiing, etc.	1.1.1	Presentation by member of Craft Committee and/or Field Representative of engine manufacturers. Lecture by teacher.	
1.1.2	Describe why more people are being attracted tothe trade .	1.1.2	State that due to the demand exceeding the supply of well qualified mechanics and related jobs the pay, benefits, advancements are more attractive.	1.1.2	Same as 1.1.1	
1.1.3	Name at least 3 sources you would try in looking for job in this field.	1.1.3	State—State Employment Office, newspaper classified ads, engine distributors, dealers, employment services.	1.1.3	Same as 1.1.1	
1.2.1	Describe 3 things that are important in prevention of fires in shop area	1.2.1	1. State extreme care in the handling of fuels and flammable liquids. 2. Good housekeeping practices i.e., wiping up spills, keeping rags, paper, etc. stored properly. 3. Being familiar with electrical circuits and their capacity. 4. Keep power tools, extension cords, etc. in good repair.			
1.2.2	Safety is whose responsibility?	1.2.2	State "EVERYONE."	1.2.2	Lecture	
1.2.3	Describe a shop safety regulation in the use of drilling,	1.2.3	State--Use safety goggles.	1.2.3	Lecture/film safety posters	

FUNCTIONAL PERFORMANCE ANALYSIS

Terminal Performance Objective 1.0
Interim Performance Objective 1.1

No.	Learning Steps	No.	Criterion Performance Evaluation (Response)	No.	Method/Media Selection	Time Requir
1.2.3	Con't. grinding, chipping, wire brushing tools.					
1.2.4	Describe why fire drills are important.	1.2.4	State that it helps train for a quick and proper response in building evacuation.	1.2.4	Lecture	
1.2.5	Demonstrate proper clothing and dress for shop work.	1.2.5	State long sleeves, loose ornaments, soft toed shoes, neckties are dangerous around revolving or moving parts, tools and machines.	1.2.5	Film/Lecture/Posters	
1.2.6	Describe behavior that can seriously, effect shop safety.	1.2.6	Select by underlining correct answers: 1. Horseplay. 2. Practical jokes. 3. Loud and boisterious talk and laughter. 4. Attention to detail.	1.2.6	Lecture/Film/Posters	

ACCREDITATION NUMBER 9363

COURSE TITLE: MARINE ENGINE MECHANICS - BASIC

TERMINAL OBJECTIVE
OBJECTIVE NO. 2.0 TOOLS

The students will demonstrate knowledge and skill developed in use and purpose of measuring devices and tools as evidenced by 80% of them answering correctly 75% of all questions on a teachers prepared test.

No.	Intermediate Performance Objectives	No.	Criterion Measures
2.1	Given (10) incomplete sentences concerning mechanics hand tools, and a list of terms, the student will select the correct word or words from the list to complete all ten sentences correctly.	2.1	1. The _____ is the proper tools used to determine the outside diameter of an item for out-of-round condtion. a. Scale b. Inside caliper c. Micrometer 2. Using a 6" scale, the distance across the top of a cylinder is 3½". This is called the_____ . a. Stroke b. Torgue c. Bore 3. A tool inserted in a hexagon shaped recesses of flush mounted screws is: a. Inside caliper b. Inside micrometer c. Set screw wrench 4. The end of a Phillips-head screwdriver is a: a. Flat Blade b. Pointed end with four grooves. c. Fluted end. 5. A screw extractor has: a. Tapered right-hand threads. b. Tapered left-hand threads. 6. Hacksaw blades are made of: a. High grade tool steel. b. Chilled cast iron. c. Carbaloy 7. A _____is used to cut external threads. a. Tap b. Set screw c. Die

ACCREDITATION NUMBER 9363

COURSE TITLE: MARINE ENGINE MECHANICS- BASIC

TERMINAL OBJECTIVE
OBJECTIVE NO. 2.0 TOOIS

No.	Intermediate Performance Objectives	No.	Criterion Measures
		2.1	8. After cutting a piece of tubing, it should be reamed to remove any _____ from the cut edge. a. Lip b. Grooves c. Burrs 9. The usual cutting lip angle on a twist drill is_____. a. 45 deg. b. 59 deg. c. 60 deg. d. 75 deg. 10. The main reason for using a box type wrench is_____. a. Greater strength. b. Used on rounded nuts. c. Less liable to slip from nut.
2	The learner will correctly identify given special tools and match to their proper function (as specified in the appropriate service manual).	2.2	1. From prints of special tools, name and describe the function of each below: a. This _____ is used_____. b. This _____ is used _____. c. This _____ is used_____. 2. Demonstrate the use of these tools on an actual engine provided by the instructor

ACCREDITATION NUMBER 9363

COURSE TITLE: MARINE ENGINE MECHANICS - BASIC

TERMINAL OBJECTIVE
OBJECTIVE NO. 2.0

TOOLS

Measuring devices.

No.	Intermediate Performance Objectives	No.	Criterion Measures
2.3	Given (4) engine discrepancies, the student will be able to locate the corrective action steps necessary to repair the problem in the appropriate service manual.	2.3	Complete the following by writing in the answer of the steps necessary to locate the discrepancy using the appropriate service manual: A. If poor compression, look for 1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 6. _____ 7. _____ 8. _____ 9. _____ B. If no compression, look for: 1. _____ 2. _____ C. If spark does not occur look for: 1. _____ 6. _____ 2. _____ 7. _____ 3. _____ 8. _____ 4. _____ 9. _____ 5. _____ 10. _____

ACCREDITATION NUMBER 9363

COURSE TITLE: MARINE ENGINE MECHANICS - BASIC

TERMINAL OBJECTIVE
OBJECTIVE NO. 2.0 TOOLS

o.	Intermediate Performance Objectives	No.	Criterion Measures
CON'T		2.3	D. During the carburetion check, the spark plug is found dry, look for: 1._____ 2._____ 3._____ 4._____
4	The learner will demonstrate his ability to follow the steps above by correcting any two of the problems above, using the service manual.	2.4	1. Using the service manual, correct an ignition system: Provided by the instructor: (1) A sheared flywheel key. (2) A shorted spark plug. 2. Demonstrate the steps required to check compression using the service manual. 3. Demonstrate the steps necessary to check a carburetion problem using the service manual if: a. The spark plug is wet_____. b. The spark plug is dry._____.
5	Given a parts manual, or service manual the student will demonstrate the ability to recognize a part, (verbally described by the instructor) in the parts manual, and write the correct part number for any given item.	2.5	1. For a 1966 Merc. 350, using a parts manual provided, write the correct ref. no. and part no. for the following items: a. Connecting rod b. Crankshaft c. Fuel Pump d. Spark Plug 2. Using the service manual, list the recommended parts and specifications for a 1962 Johnson RD-24 engine: a. Spark Plug_____ _____ _____ b. Hp @ RPM _____@_____ c. Cu. in. displacement_____

ACCREDITATION NUMBER 9363

COURSE TITLE: MARINE ENGINE MECHANICS - BASIC

TERMINAL OBJECTIVE
OBJECTIVE NO. 2.0

TOOLS

No.	Intermediate Performance Objectives	No.	Criterion Measures
2.0 con't.		2.5	3. Describe in writing the difference between: A. Service manual & parts manual. B. Reference number & part number. 4. The letter "E" in an OMC model number indicates an _____ _____. 5. The Chrysler 1967 Model 357 uses a _____ carburetor. 6. The Evinrude, Gale & Johnson engines are made by the _____ _____.

tudent name_____ Date_____

. On the next page you will see pictures of wrenches, each of which has a small number next to it. Look at the picture, and place the number on this sheet next to the proper name for that wrench.

( )	UNIVERSAL JOINT	( )	VICE-GRIP WRENCH
( )	8 - POINT SOCKET	( )	SPEED TEE
( )	EXTENSION BAR	( )	COMBINATION WRENCH
( )	OPEN END WRENCH	( )	SLIDING T HANDLE
( )	12-POINT SOCKET	( )	RATCHET HANDLE
( )	SPEED HANDLE	( )	FLARE NUT WRENCH
( )	DOUBLE BOX WRENCH	( )	SOCKET DRIVER
( )	SET SCREW WRENCH (ALLEN)	( )	RATCHET ADAPTER
( )	SOCKET WRENCH SET	( )	PIPE WRENCH
( )	FLEXOCKETS	( )	FLEXTENSION
( )	MONKEY WRENCH	( )	SPANNER WRENCHES
( )	ADJUSTABLE END WRENCH	( )	FLEX HANDLE (HINGE)
( )	TORQUE WRENCH	( )	DEEP SOCKET (12-POINT)

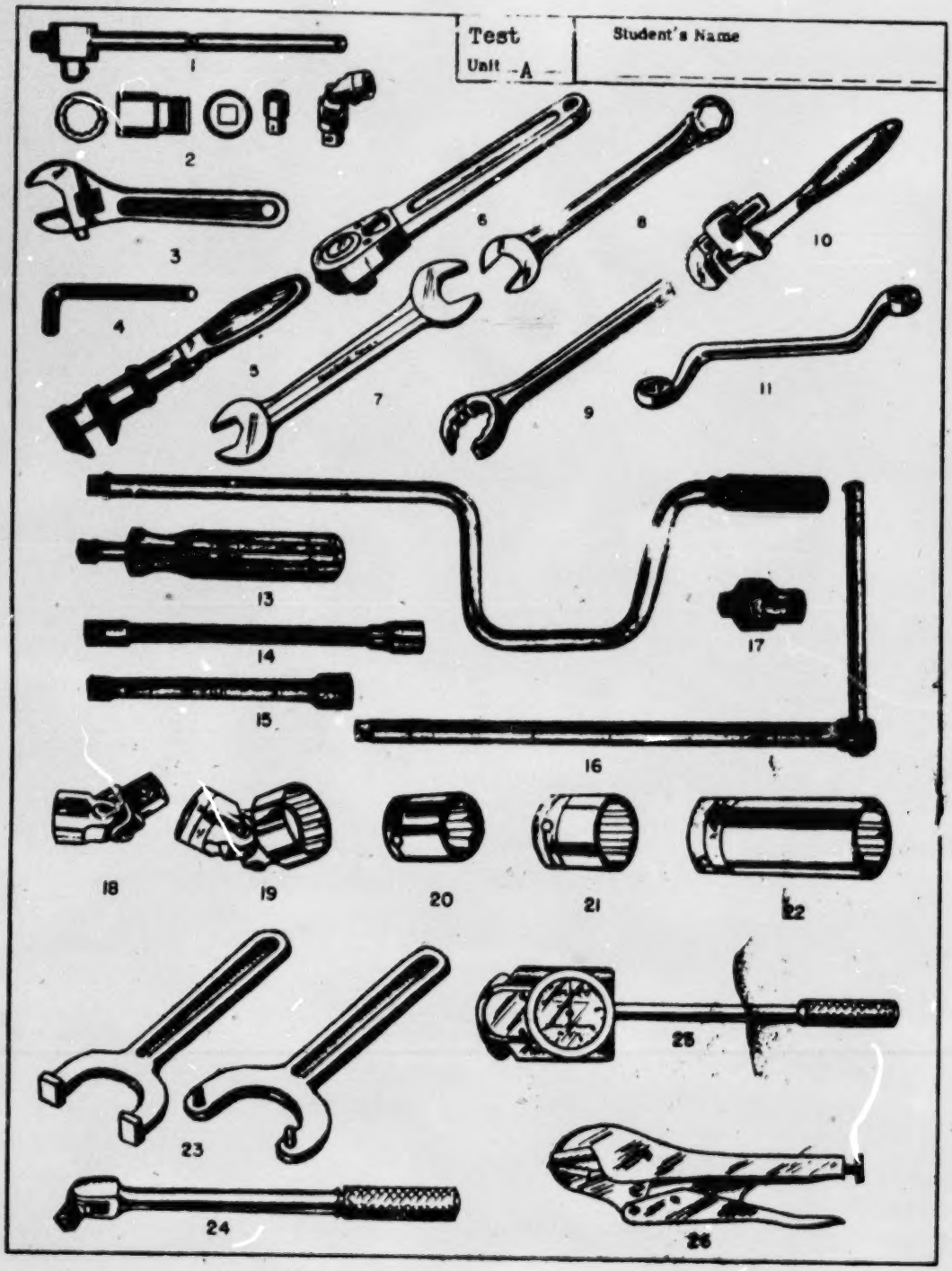
. Place the number, or numbers, of the tools on the blanks after the statement which best describes their use and purpose.

(1) Size on both ends same._____

(2) In a hollow set screw_____.

(3) In tightening nuts to a specified tightness_____

(4) When a particularly tight grip is required to hold material_____


Test
Unit -A-
Student's Name
1
2
3
4
5
6
7
8
9
10
11
13
14
15
16
17
18
19
20
21
22
23
24
25
26

BLOCK II Measuring Devices

UNIT B Special Tools (Measuring)

- T E S T -

1. On the attached sheet the figures are numbered. Insert the figure number in the space next to the name of the tool to which it corresponds.

( ) Snap gage, adjustable type
( ) Inside caliper
( ) Steel Rule
( ) Feeler gage
( ) Micrometer caliper
( ) Telescoping gage
( ) Outside caliper
( ) Steel Tape-rule
( ) Dial indicator
( ) Tap and drill gage
( ) Plug or "go"-"no-go" gage
( ) Snap gage, plain type
( ) Screw-pitch gage

2. In the space provided below, give the dimensions numbered 1 through 24 in Figure 2:

1._____ 5._____ 9._____ 13._____ 17._____
2._____ 6._____ 10._____ 14._____ 18._____
3._____ 7._____ 11._____ 15._____ 19._____
4._____ 8._____ 12._____ 16._____ 20._____

21._____
22._____
23._____
24._____

3. Place the number or numbers of the tools (Figure numbers) on the blanks following the statement which best describes the use and purpose, or ask yourself, "Used to measure what?"

A. The size of a drill _____
B. Limits on outside diameters _____
C. Either common fractions to sixty-fourths of an inch or decimal fractions to one-hundredths of an inch _____
D. The number of threads per inch of a bolt or a nut. _____

4. In figures 14 to 18 inclusive, insert the correct decimal fractions in all of the blank spaces below:

Fig. 14 a._____ b._____
Fig. 15 a._____ B._____
Fig. 16 a._____ b._____
Fig. 17 a._____
Fig. 18 a._____

Test
Unit B

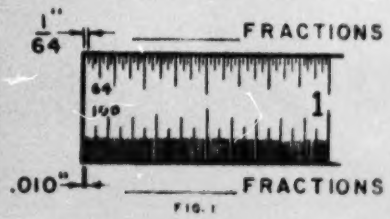
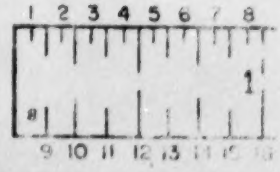
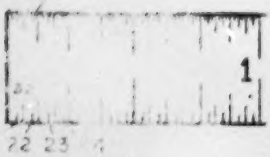


FIG. 1





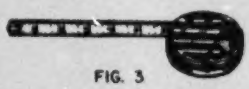


FIG. 3

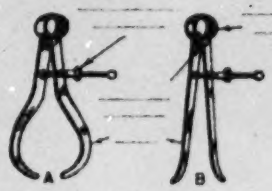


FIG. 4

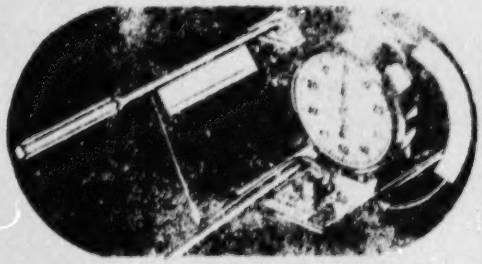


FIG. 5

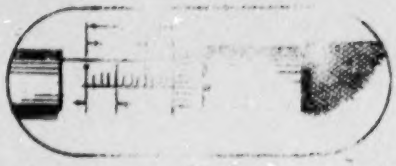


FIG. 14

FIG. 6

FIG. 7

FIG. 8

FIG. 13

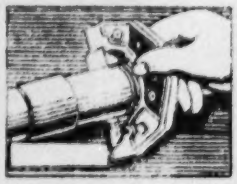


FIG. 12

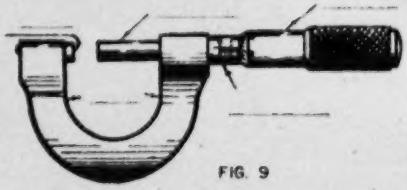


FIG. 9

FIG. 10

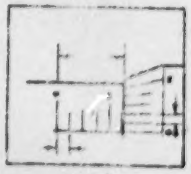


FIG. 15

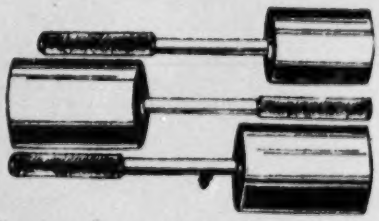


FIG. 11

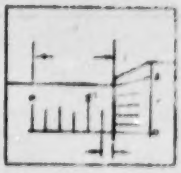


FIG. 16

FIG. 17

FIG. 18

FUNCTIONAL PERFORMANCE ANALYSIS

Terminal Performance Objective 2.0
Interim Performance Objective 2.1

No.	Learning Steps	No.	Criterion Performance Evaluation (Response)	No.	Method/Media Selection	Time Requir
2.1.1	Locate tools on visual display board common to the trade.	2.1.1	Write names of each tool with 100% accuracy.	2.1.1	Lecture/Instructor Demonstration and printouts	
2.1.2	Recognize that different tools have different purposes.	2.1.2	Match the correct name to the picture of tools provided with 100% accuracy for job described.	2.1.2	Lecture/Demonstration Class discussion	
2.1.3	Utilize 6" scale for measuring.	2.1.3	Measure all lines on hand out given must be accurate to 100%.	2.1.3	Lecture/Film Class practice printout.	

ACCREDITATION NUMBER 9363

COURSE TITLE: MARINE ENGINE MECHANICS - BASIC

TERMINAL OBJECTIVE
OBJECTIVE NO. 3.0

ENGINE CONSTRUCTION

Upon completion of the engine unit of instruction 90% of the students will answer 85% of attached criterion test correctly.

No.	Intermediate Performance Objectives	No.	Criterion Measures
.0		3.0	1. The major difference between a two-stroke and four-stroke cycle engine is _____ _____ _____.
			2. From the attached sheet, pick out the proper momenclature for the parts with the arrow. (see attached test 1)
			3. Viscosity is_____ _____ _____.
			4. Volitility is_____ _____ _____.
			5. The cylinder head bolts must be installed and tightened according to a _____ and _____ prescribed by the individual engine manufacturer.
			6. Lapped valves must contact the seat with _____"and have a min. margin above_____".
			7. What tool is used to measure a cylinder for out of round?_____
			8. Worn bearings should be: A. Replaced B. Reamed smooth
			9. Insert the name to the section of the piston that the arrows are pointing: (See attached test I)
			10. A piston is considered worn out if a _____ feeler gauge fits between the groove and the top ring.
			11. Scratches below the rings indicate: 1. Dirty air filter 2. No air filter 3. Dirty oil 4. Discolored oil

ACCREDITATION NUMBER 9363

COURSE TITLE: MARINE ENGINE MECHANICS - BASIC

TERMINAL OBJECTIVE
OBJECTIVE NO. 3.0 ENGINE CONSTRUCTION

No.	Intermediate Performance Objectives	No.	Criterion Measures
3.0	Con't.	3.0	12. It is important that the manufacturer's recommended type of oil and the proper oil to _____ ratio be followed in the 2 cycle engine. 13. Timing of the engine is accomplished by _____ the cam shaft and the Crank Shaft Timing mark.
3.1	Given a print out of the events that take place in a 4 stroke cycle engine, the student will indentify each stroke and relate parts with 100% accuracy.	3.1	(see attached print-out)
3.2	Given a list of parts, the student will select with 80% accuracy these pertaining to an engine.	3.2	Circle these parts found in an air-cooled engine: 1. wheel 6. oil pump 2. camshaft 7. radiator 3. valve (poppet) 8. flywheal 4. cylinder 9. cylinder fins 5. transmission 10. cam lobe
3.3	Given the problem of sketching each event in a 4-stroke cycle engine, the student will correctly locate the parts in their relationship to each other.	3.3	Performer will be evaluated by the criterion in the objective.
3.4	The student will compare the 2-stroke cycle & 4-stroke cycle by selecting the advantages & disadvantages of each with 80% accuracy.	3.4	Using 2S (s-stroke) & 4s (4-stroke), place before each statement the correct symbol. 1. _____ The most simple & efficient engine design from the standpoint of fuel & exhaust gas mixture movement.

ACCREDITATION NUMBER 9363

COURSE TITLE: MARINE ENGINE MECHANICS - BASIC

TERMINAL OBJECTIVE
OBJECTIVE NO. 3.0 ENGINE CONSTRUCTION

No.	Intermediate Performance Objectives	No.	Criterion Measures
3.4	Con't.	3.4	2. _____ All events in the cycle take place in two strokes of piston. 3. _____ The complicated system of valving adds materially to the weight & original cost of the engine. 4. _____ Horsepower to weight ratio is more favorable 5. _____ Generally more economical when fuel costs alone are considered. 6. _____ Called "Crankcase scavenged" & are used almost universally in the outboard motor industry. 7. _____ Has most efficient lubricating system. 8. _____ Lends itself for using a variety of fuels. 9. _____ Uses deflector on top of piston. 10. _____ Reed valve sometimes used as intake valve.
3.5	Given a schematic print-out of the crankcase scavenged, reed valve type, 2-stroke cycle engine, the student will correctly label the parts & events.	3.5	Performer will be evaluated by the criterian in the objective.

TEST
(TYPICAL)

Assignment Unit 17 | Student's Name _____

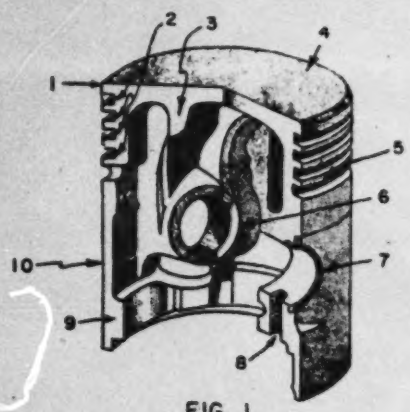


FIG. 1

FIG. 2

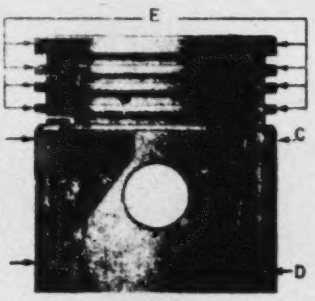


FIG. 3

ASSIGNMENT

REFERENCES

	Pages
Automotive Fundamentals	58-61
Automotive Mechanics	24-28

A Insert the number next to the name of the part to which it corresponds. (Fig. 1)

1. ( ) Threaded hole for piston pin
2. ( ) Head
3. ( ) Top land
4. ( ) Skirt
5. ( ) Piston pin boss
6. ( ) Head rib
7. ( ) Grooves
8. ( ) Locking snap ring groove
9. ( ) Skirt reinforcement
10. ( ) Oil drain holes

B Complete the following statements by inserting the correct letter in the blank spaces. NOTE: Figures 2 and 3 are bottom and side views of a cam-ground piston showing different dimensions of the one.

1. The piston land diameters should be 0.028 to 0.033 inches less than the diameter at _____.
2. The elliptical shape of the piston skirt should be 0.010 to 0.012 inches less at diameter _____ than across the thrust faces at diameter _____.
3. The skirt of the piston should taper so that the diameter at _____ is from 0.0005 to 0.0015 inches less than at _____.
4. The thrust axis is represented by diameter _____ in Figure 2.
5. Diameter _____ in Figure 2 will increase the greatest amount when the piston becomes hot.

RELATED PROBLEMS

1. Why are some pistons called "cam-ground pistons"?

_____

2. Why do cam-ground pistons assume a round shape when they warm up?

_____

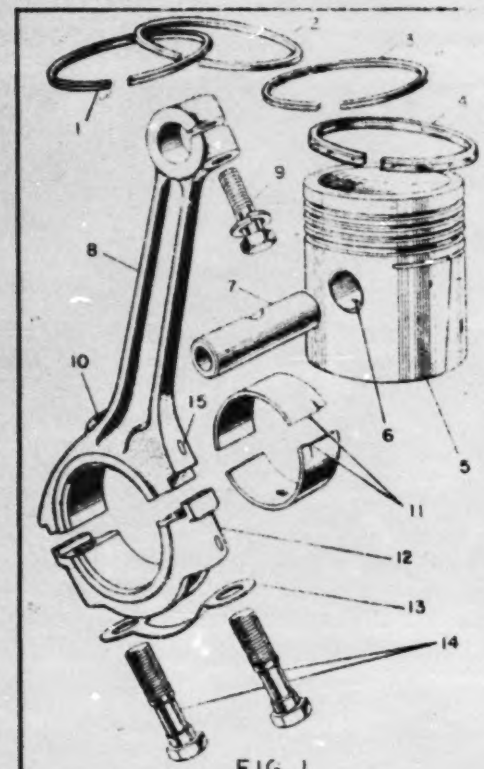


FIG. 1

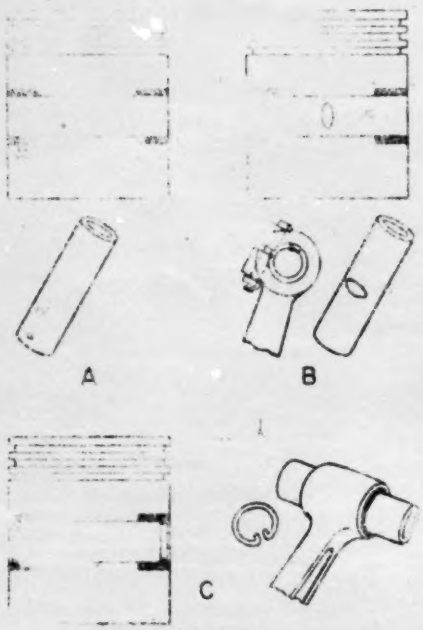


FIG. 2

ASSIGNMENT

A ➧ Label the components indicated by numbers 1 to 15 in Figure 1.

B ➧ Identify the types of piston-pin locking in Figure 2 by inserting the letter in the space next to the name to which it corresponds.

1. ( ) Full-floating pin
2. ( ) Fixed pin
3. ( ) Semifloating pin

REFERENCES	Pages
Auto. Fundamentals	60, 61, 67-69
Auto. Mechanics	24-29, 60, 79-81

RELATED PROBLEMS

1. What is the main reason for locking the piston pin in the connecting rod or piston? _____

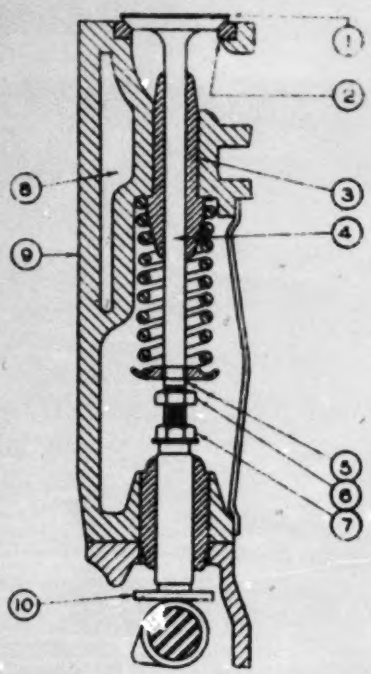
2. Describe briefly the three types of piston-pin locks as shown in Figure 2.

   a. _____

   b. _____

   c. _____

TEST
(Typical)



Student's Name

1 _____
2 _____
3 _____
4 _____
5 _____
6 _____
7 _____
8 _____
9 _____
10 _____

ASSIGNMENT

A Study the section drawing of the valve and block assembly.

B Identify the main valve assembly parts by lettering the part names in the space provided for each one.

REFERENCES

	Pages
Automotive Fundamentals	71, 76
Automotive Mechanics	31-33

RELATED PROBLEMS

1. What returns the valve to its seat after it has been raised by the cam?

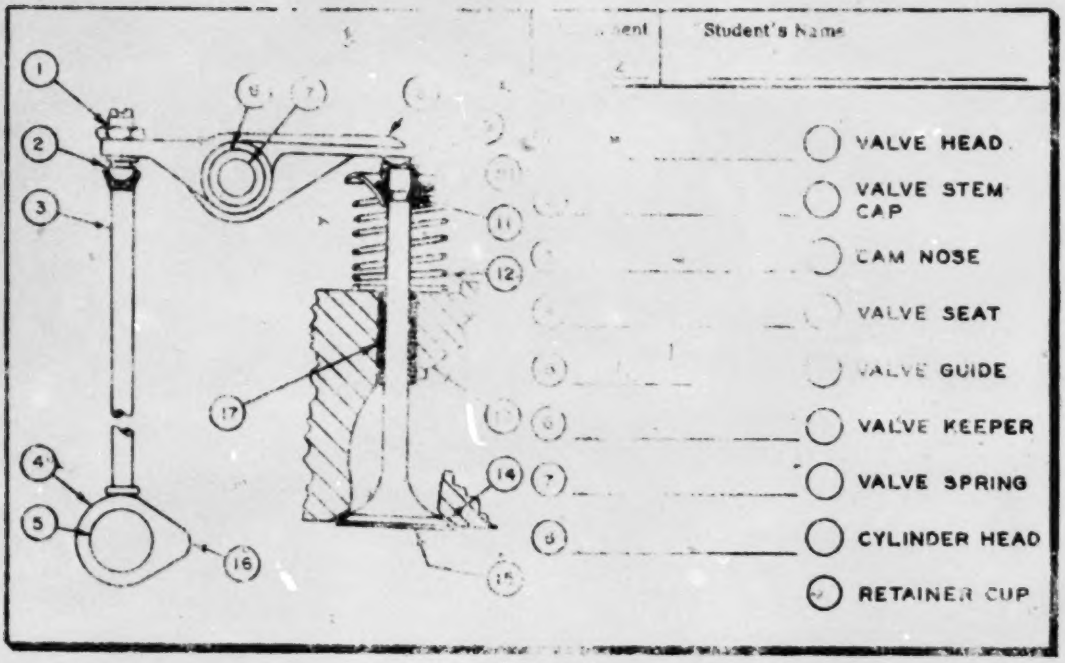
   _____

2. Why is it necessary to have some clearance between the valve and valve lifter? _____

   _____

   _____

   _____



ASSIGNMENT

A ◗ Study the drawing of the valve [illegible] assembly.

B ◗ Identify parts numbered 1 through 8 by naming the parts in the space provided for each one.

C ◗ Insert the number in the encircled [illegible] to the name of the part to which it corresponds.

REFERENCES

	Pages
Automotive Fundamentals	37, 71, 76, 77
Automotive Mechanics	19, 32, 33

RELATED PROBLEMS

1. When the engine is being warmed up, do all units of the valve assembly expand at the same rate? Explain. _____

2. Why must the end of the rocker arm, contacting the valve stem, have a rounded surface? _____

3. Will a bent or worn push rod increase or decrease the lift of a valve? _____

FUNCTIONAL PERFORMANCE ANALYSIS

Terminal Performance Objective 3.0
Interim Performance Objective 3.1

No.	Learning Steps	No.	Criterion Performance Evaluation (Response)	No.	Method/Media Selection	Time Required
.1.1	Define an engine cylinder	3.1.1	A cylinder is a sealed straight walled tube.	3.1.1	Lecture/mock-up	
.1.2	Describe: what is the purpose of a cylinder?	3.1.2	Provides a chamber for combustion of fuel.	3.1.2	Lecture/Theory	
.1.3	Describe components within a cylinder assy.	3.1.3	Circle the components that belong in the assy.	3.1.3	Graphics/Mock-up	
.1.4	Describe how a cylinder is sealed.	3.1.4	State that it is sealed by cylinder head and piston ring.	3.1.4	Lecture/Mock-up	
.1.5	Why is a good seal important?	3.1.5	State that it increases compression and prevents "blow by".	3.1.5	Lecture/Theory	
.1.6	What is a piston?	3.1.6	Slide device in cylinder which the pressures act on, connected to the crankshaft by means of the connecting rod.	3.1.6	Lecture/Mock-up	
.1.7	What is the function of the valves on the 4-stroke cycle engine?	3.1.7	Provides an opening for intake and exhaust.	3.1.7	Lecture/Graphics	33

FUNCTIONAL PERFORMANCE ANALYSIS

Terminal Performance Objective 3.0
Interim Performance Objective 3.1

No.	Learning Steps	No.	Criterion Performance Evaluation (Response)	No.	Method/Media Selection	Time Required
.1.8	Describe the position of both valves and the piston on the intake stroke?	3.1.8	Intake valve open, exhaust valve closed, piston travels down in cylinder.	3.1.8	Lecture/Graphics	
.1.9	Describe the position of both valves and piston on compression strokes.	3.1.9	Both valve closed, piston moving upward in cylinder.	3.1.9	Lecture/Graphics	
.1.10	Describe the position of the valves and piston on the power stroke.	3.1.10	Both valves closed and piston travels down in cylinder.	3.1.10	Lecture/Graphics	
.1.11	Describe the positions of the valves and piston on the exhaust stroke.	3.1.11	Intake valve closed, exhaust valve open, piston moves upward in cylinder.	3.1.11	Lecture/Graphics	
.1.12	Pressures and temperatures are greatest in the cylinder during which stroke?	3.1.12	Underline 1. Intake. 2. Compression. 3. Power 4. Exhaust	3.1.12	Lecture/Graphics	

35

ACCREDITATION NUMBER 9363

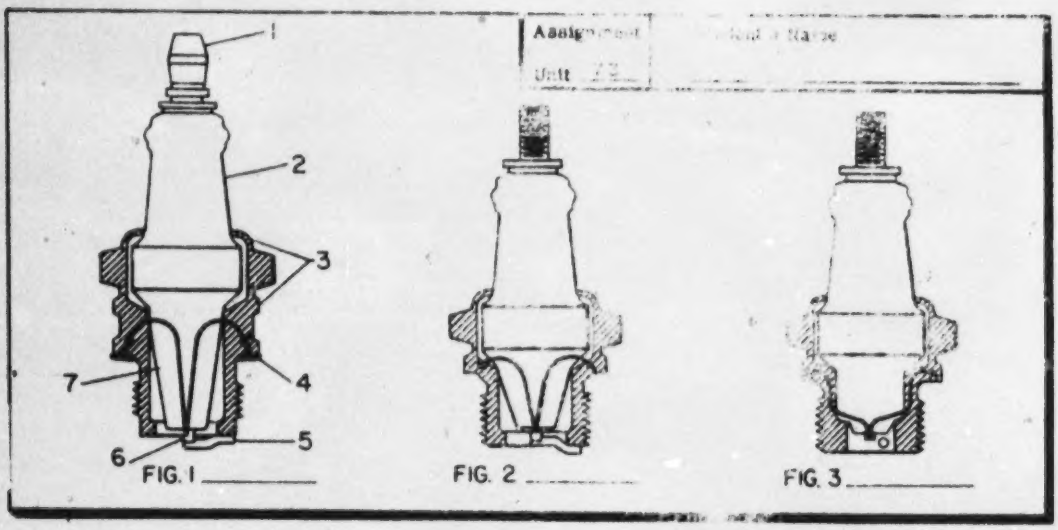
COURSE TITLE: MARINE ENGINE MECHANICS - BASIC

TERMINAL OBJECTIVE
OBJECTIVE NO. 4.0 IGNITION SYSTEM

Upon completion of the Ignition Unit of instruction 90% of the students will answer 75% of attached criterion test correctly. In addition trainee will disassemble, time and assemble the ignition system on three different make engines.
Procedures required will be 100% complete as defined.

No.	Intermediate Performance Objectives	No.	Criterion Measures
0		4.0	(See attached test)
1	The learner will list the basic items required to complete a magneto ignition circuit.	4.1	Sketch and name those items necessary to complete a magneto ignition circuit.
2	Given a print out, the student will identify special tools used for ignition inspection.	4.2	In the blank next to the picture of special tools insert the proper name of ignition tools only.
3	Given test equipment the student will demonstrate ability to follow instruction manual and properly use test equipment.	4.3	Use the Mer-O-Tronic Tester to: a. Make a continuity check b. Check a condenser for leakage. c. Check a coil for operating amperage.
4	The student will determine a "hot" plug by interpreting a printout of three plugs.	4.4	Criterion contained in I.P.O.
5	The student will choose the correct order of trouble shooting an ignition problem out of 3 given methods.	4.5	Criterion contained in I.P.O.
6	The student will determine which statement is correct on a printout of ignition tools to match particular tool use.	4.6	(See attached"match" printout)

UNIT D SPARK PLUGS
TEST
(TYPICAL)



ASSIGNMENT

A ◗ **Study the pages and illustrations in the references cited.**

B ◗ **Label Figures 1, 2 and 3 to indicate the heat range.**

C ◗ **Name the spark plug parts in the columns so that the number of the parts in Figure 1 correspond with the numbered lines in the columns.**

1. _____ 5. _____
2. _____ 6. _____
3. _____
4. _____

REFERENCES

	Pages
Automotive Fundamentals . .	336, 337
Automotive Mechanics . . .	298-301

RELATED PROBLEMS

Where a statement is true, encircle the T; where a statement or any part of a statement is false, encircle the F.

1. A plug designed for a hot engine has a shorter insulator firing tip. T F
2. Variation in the speed of heat transfer from the plugs to the cooling system is the heat range of spark plugs. T F
3. Plugs designed for aluminum heads have more threads than those designed for cast iron. T F
4. The final selection of the proper "heat range" should be governed by the actual operating conditions of the vehicle involved. T F
5. It is never advisable to deviate from the recommended plug heat range. T F

FUNCTIONAL PERFORMANCE ANALYSIS

Terminal Performance Objective 4.0
Interim Performance Objective 4.1

No.	Learning Steps	No.	Criterion Performance Evaluation (Response)	No.	Method/Media Selection	Time Required
1.1	Locate required parts on visual display.	4.1.1	Write names for each - relating names to part with 100% accuracy.	4.1.1	Make-up, lecture, class discussion.	
1.2	Identify ignition parts on engine make up.	4.1.2	Recall parts by name from make-up as requested by instructor.	4.1.2	Ignition make-up SKETCH LECTURE	
2.1	Identify special tools used for ignition inspection.	4.2.1	Explain the purpose of various ignition special tools as illustrated on handout with 100% accuracy.	4.2.1	Printout on special tools, lecture, feeler guage, puller, ignition tester, flywheel holder, clutch wrench, spark plug guage demonstration by instructor on the used of each.	
2.2	Demonstrate proper use for various ignition tools.	4.2.2	Using special tools provided, demonstrate the use for each on an ignition system provided by instructor.	4.2.2	Ignition special tools air cooled engine class practice service manuals.	
3.1	Demonstrate ability to use test equipment.	4.3.1	State the names of ignition parts that can be tested on the ignition analyser.	4.3.1	Merc-o-Tronic tester condensers, wires, plugs, coils. Service manuals. Lecture.	
4.1	Identify various differences in spark plug heat ranges.	4.4.1	State the difference between a hot and cold plug is the length the heat must travel. From the tip of the plug, through the insulator, to the plug shell, and finally to the cylinder head. The longer the travel, the better the plug.	4.4.1	Lecture Transparencies Selection of spark plugs.	39

FUNCTIONAL PERFORMANCE ANALYSIS

Terminal Performance Objective 4.0
Interim Performance Objective 4.1

No.	Learning Steps	No.	Criterion Performance Evaluation (Response)	No.	Method/Media Selection	Time Required
5.1	Choose the correct order of steps in trouble shooting an ignition problem.	4.5.1	Write the steps necessary to solve the ignition problems (paying particular attention to the order) Given on worksheet use the service manual.	4.5.1	Lecture Appropriate service manuals.	
.6.	...ct the proper tools to dis-...embly complete when all parts bolts, nuts, etc. are placed in a container.	.6.1	Disassemble the ignition system (points, coil, condenser, etc.) Disassembly complete when all parts bolts, nuts, etc. are placed in a container.	4.6.1	Basic Engine for class use Service manuals Required tools	
.7.1	Select the proper tools to reassemble an ignition system provided by instructor.	4.7.1	Reassemble an ignition system (point, coil, condenser, etc.) make necessary adjustments. Secure all nuts, bolts, wires, screws, etc. in their correct location and proper torque.	4.7.1	Basic Engine for class use. Service manuals. Required tools. Demonstration.	

ACCREDITATION NUMBER 9363

COURSE TITLE: MARINE ENGINE MECHANICS- BASIC

TERMINAL OBJECTIVE
OBJECTIVE NO. 5.0 FUEL SYSTEM

The student will demonstrate his knowledge and skills of fuel system and carburetion as evidenced by 85% of the students answering 75% of the Criterion test questions correctly.

No.	Intermediate Performance Objectives	No.	Criterion Measures
.0		5.0	1. Describe the purpose of the carburetor. 2. Name the parts in the fuel system. 3. The float type carburetor uses _____ fuel pressure. 4. The Suction type carburetor is easily identified by it's location to the _____. 5. _____ pressure working on a diaphragm produces fuel pressure for the McCulloch chain saw. 6. A ruptured diaphragm in a fuel pump is detected by: (See attached) 7. The initial carburetor adjustments of the following are (See attached) 8. After an overhaul performed on a carburetor, the engine will not run. The cause could be: (See attached) 9. The purpose of the _____ is to increase the speed of the air flow and decrease the pressure in the carburetor throat. 10. The 3 things necessary for the operation of the internal combustion engine are: Select 1 answer: a. oil, water, fuel. b. air, fuel, ignition. c. fuel, air, water. 11. Pressures and temperatures are lowest in the cylinder during the _____ stroke.

ACCREDITATION NUMBER 9363

COURSE TITLE: MARINE ENGINE MECHANICS - BASIC

TERMINAL OBJECTIVE
OBJECTIVE NO. 5.0 FUEL SYSTEM

No.	Intermediate Performance Objectives	No.	Criterion Measures
5.0	Con't.		12. In the float type carburetor the proper fuel level is maintained in the float chamber by the _____ valve.
5.1	The student will demonstrate his understanding of the composition of fuels, proper handling of and its application to internal combustion engines by completing successfully 70% of the criterion questions.	5.1	1. List two safety rules in the handling of fuels. (1) _____ (2) _____ 2. As a result of combustion gasoline produces carbon monoxide, or CO, which is a _____ poisonous gas. 3. 15 parts of this gas to 10,000 part of air can cause quick paralysis or _____. 4. Can you tell by the odor whether or not carbon monoxide is present in a room Yes No 5. Which liquid evaporates most rapidly: (1) Water (3) Oil (2) Gasoline This is because it has a _____ boiling point. 6. Rags, especially those which have been used around fuels, are subject to spontaneous combustion, therefore, extreme care must be taken in their _____.

ACCREDITATION NUMBER 9363

COURSE TITLE: MARINE ENGINE MECHANICS - BASIC

TERMINAL OBJECTIVE
OBJECTIVE NO. 5.0 FUEL SYSTEM

No.	Intermediate Performance Objectives	No.	Criterion Measures
5.1	Con't.	5.1	7. Gasoline should be stored in: A. A closed metal container B. A closed glass container C. A closed plastic container 8. An _____ cleaner is mounted on the carburetor intake to screen out dust and grit. 9. The cleaner also acts as a flame arrester in case the engine _____ through the carburetor. 10. When a liquid changes to _____ it is said to evaporate.
5.2	Given a carburetor student will disassemble completely, indentifying each part by name and function-then reassemble and adjust to manufacturers specifications.	5.2	Critera contained in I.P.O.
5.3	The student will diagnose malfunction (previously created by instructor) on an installed carburetor, and make proper repair/adjustment so that engine will run.	5.3	Criteria contained in I.P.O.
5.4	The student from memory will draw a sketch of a fuel system labeling by name the main components with 100% accuracy.	5.4	Criteria contained in I.P.O.
5.5	Given a two-cycle engine the student will determine the proper fuel-oil mixture by utilizing the Handbook of Service Instructions for that specific engine.	5.5	Criteria contained in I.P.O.

FUNCTIONAL PERFORMANCE ANALYSIS

Terminal Performance Objective 5.0
Interim Performance Objective 5.1

o.	Learning Steps	No.	Criterion Performance Evaluation (Response)	No.	Method/Media Selection	Time Required
1.1	Define fuel-air mixture.	5.1.1	State fuel broken into fine particles and mixed with air. To burn properly a vapor mist is desired.	5.1.1	Lecture	
1.2	Why is air necessary?	5.1.2	State oxygen is needed for burning.	5.1.2	Lecture	
1.3	Define air-fuel ratio?	5.1.3	Write parts of air compared to parts of fuel in the fuel-air mixture.	5.1.3	Lecture	
1.4	Describe how fuel is broken into particles and mixed with air in the carburetor.	5.1.4	State by the velocity of air rushing through the carb. throat.	5.1.4	Demonstration Spraying liquid from spray gun.	
2.4	Describe the spark plug method of testing the fuel-air mixture on a 2-cycle engine.	5.2.4	Relate that a black carbon deposit indicates that mixture is too rich, prolonged idling, too much oil in fuel, or low ignition voltage.			
		5.2.5	Relate that a white or light gray deposit could be caused by a lean mixture.			

FUNCTIONAL PERFORMANCE ANALYSIS

Terminal Performance Objective 5.0
Interim Performance Objective 5.1

No.	Learning Steps	No.	Criterion Performance Evaluation (Response)	No.	Method/Media Selection	Time Required
3.1	Explain why a carburetor will not function and engine not run if air filter is clogged or obstructed.	5.3.1	State that enough air is not mixed with fuel causing a "too rich" mixture which will not burn.	5.3.1	Lecture Demonstration	
.3.2	Describe symptons of needle valve stuck in open position.	5.3.2	Relate that flooding of carburetor happens causing a "too-rich" mixture, engine runs erratically or will not run.	5.3.2	Lecture Demonstration	
.3.3	Describe symptons of a needle valve stuck in closed position.	5.3.3	Relate that carburetor will be starved and engine will not operate.	5.3.3	Lecture Demonstration	

ACCREDITATION NUMBER 9363

COURSE TITLE: MARINE ENGINE MECHANICS- BASIC

TERMINAL OBJECTIVE
OBJECTIVE NO. 6.0 DRIVE UNIT

Upon completion of this block of instruction 90% of the students will answer 75% of attached criterion test correctly In addition trainee will disassemble, find malfunction if any and reassemble the drive unit on an outboard engine. Procedures will be 100% as defined

No.	Intermediate Performance Objectives	No.	Criterion Measures
		6.0	(See attached test)
6.1	The learner will label the parts on a print-out of an outboard drive unit and describe their use.	6.1	Criteria contained in I.P.O.
6.2	Given an outboard engine with instructor created discrepancies student will correctly trouble-shoot and repair lower unit	6.2	Performer will be evaluated by the criteria in the objective
.3	The student will demonstrate his understanding of troubleshooting the drive unit by 80% answering 75% of the criterion tests correctly.	6.3	Complete the following sentences 1 _____ slippage on a racing hull may be as low as 10% 2 Low top RPM and no acceleration could be caused by too _____ pitch propeller 3 SAE #30 gear case lube residue in water pump is caused by _____ drive shaft seal. 4 A bent gearcase or exhaust tube could cause _____ acceleration and dying down at high power 5 A worn gear dog will cause the shifter _____ to jump Select the most accurate: 6 Electric shift inoperative or slips: a. Burned piston b. Too advanced timing c. Loose or sprung gear case. d. Loose distributor pulley. 7. A stainless steel propeller is more easily worked than bronze T. F. 8. Propellers should usually not be changed from that recommended by the manufacturer T. F.

BLOCK VI- DRIVE UNIT

Complete the statements below:

1. The drive unit contains the drive_____

2. The power head delivers power to a _____ shaft which is geared to turn a _____ shaft, this delivering thrust to propel the boat.

3. The gears, shafts and supporting bearings are contained in a _____weight housing or gear case.

4. To perform efficiently, the gear case must be kept as small as possible and well_____to cut down interference with smooth_____flow.

5. The lower unit also serves as the _____to steer the boat.

6. Because the direction of _____turns with the rudder, the system is unusually efficient.

7. Propellers are rated by:
   a. diameter
   b. Pitch
   c. Number of Blades
   d. All of the Above.

8. When not moving, any boat will displace:
   a. It's own weight in water
   b. ½ It's weight in water
   c. 1/3 it's weight in water
   d. ¼ it's weight in water

9. Too little propeller pitch will cause the engine to:
   a. Under speed
   b. Overspeed
   c. "Lug "
   d. Not affect operation

10. Propeller cavitation becomes more of a problem:

    a. At idling speed
    b. In rough water
    c. At high speeds
    d. In reverse

11. The outboard engine exhaust is usually vented to the outside underneath the water level:

    a. To prevent carbon monoxide from entering the atmosphere
    b. To cool exhaust gases
    c. To silence engine noise
    d. To prevent after fire

12. The flat blade propellers operate efficiently:

    a. Only at slow rotation
    b. Only at fast rotation
    c. At any range speed
    d. On heavy loads

Circle True or False

13. T F An outboard motor moves a boat through the water in somewhat the same manner that a wood screw passes through a piece of wood.

14. T F There is no set rule for matching a propeller, boat and motor.

15. T F The two bladed propeller is usually preferrable for water skiing.

16. T F The operating height of the propeller is not important.

17. T F A minor adjustment in tilt angle can make considerable difference in the speed and performance of the unit.

18. T F The outboard engine exhaust usually enters the water immediately ahead of the propeller.

19. T F A bent skeg will cause vibration in the lower unit.

20. T F Improper adjustment of the manual start lock will not prevent engine from cranking.

Performance:

Given an outboard motor, with proper manuals and tools, student will remove drive unit, disassemble, find malfunction if any, and reassemble using proper seals, torques, etc. with 100% accuracy.

FUNCTIONAL PERFORMANCE ANALYSIS

Terminal Performance Objective 6.0
Interim Performance Objective 6.1

No.	Learning Steps	No.	Criterion Performance Evaluation (Response)	No.	Method/Media Selection	Time Required
6.1.1	Define the purpose of the drive shaft	6.1.1	Delivers power from the power head to the propeller shaft.	6.1.1	Lecture/Model	
6.1.2	Describe: What is an extension kit?	6.1.2	Kit used for converting an outboard motor to either a long or short shaft motor by the installation (or removal) of.	6.1.2	Lecture/Model	
6.1.3	Define the secondary function of the drive shaft.	6.1.3	Drive water pump.	6.1.3	Lecture/Model	
6.1.4	Describe the function of the propeller.	6.1.4	Provides thrust to drive boat through water.	6.1.4	Lecture/Theory	
6.1.5	Define the materials used in making propellers.	6.1.5	State usually made of aluminum or bronze, although some plastic props have been made. Stainless steel is sometimes used for racing propellers.	6.1.5	Lecture/Theory	
6.1.6	Define slippage of a propeller.	6.1.6	State slippage is the difference between the distance a boat actually moves forward with each turn of the propeller, and the theoretical distance indicated by the pitch.	6.1.6	Lecture/Theory	

FUNCTIONAL PERFORMANCE ANALYSIS

Terminal Performance Objective 6.0
Interim Performance Objective 6.1

No.	Learning Steps	No.	Criterion Performance Evaluation (Response)	No.	Method/Media Selection	Time Required
6.1.7	Define the effect of propeller pitch on engine speed.	6.1.7	State too little pitch will cause engine to overspeed, too much pitch will not allow the engine to reach the proper speed.	6.1.7	Lecture/Theory	
6.1.8	Define: What is "cavitation"	6.1.8	State above a certain critical speed, water is moved from the blade area faster than additional water can flow into the area behind the blades.	6.1.8	Lecture/Theory	
6.1.9	Describe what effect the shape of the gear case has on the propeller.	6.1.9	State to perform efficiently the gear case must be kept small as possible and well streamlined to interfere a little as possible with the water flow to prop.	6.1.9	Lecture/Model	
6.1.10	Describe the necessity for strength and rigidity in the gear case.	6.1.10	State the speed and pressures of today's larger engines.	6.1.10	Lecture/Theory	